Occultation Science from the Sixties to Present

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Atmospheric radio occultation was born in the early days of interplanetary flight. Scientists seeking to extract the most from brief flyby encounters noted that as a spacecraft passed behind a planet, its radio links would be systematically refracted by the atmosphere. They began devising ways to deduce atmospheric properties from the observed Doppler shift, attenuation, and scintillation. The first proposals came from Stanford University and JPL in the early sixties, for NASA's Mariner 3 and 4 missions to Mars. Thus began a pioneering collaboration that established "radio science" as a mainstay of planetary exploration. In the mid sixties, the Stanford-JPL team introduced the Abel inversion technique in which the bending angle induced by the atmosphere is tapped to recover precise refractivity profiles. Radio occultation has now probed the atmospheres of nearly every planet in the solar system and many of their moons, and revealed properties of planetary surfaces and ring systems as well.

It is only recently, however, that radio science has been applied fruitfully to Earth. To be of value in studying our own atmosphere, such measurements must be comprehensive and continuous; we require many transmitters and receivers aloft at once, densely sampling the global canopy every few hours. While there were suggestions in the 1960's for adapting radio occultation to Earth, the cost of the extensive required infrastructure was prohibitive. The many-billion-dollar investment in basic infrastructure has now been made for entirely different reasons; and the occultation sensor is not only inexpensive but is becoming almost universally required for navigation and timing on low earth satellites.

Occultation science today takes many forms and encompasses optical sources as well, principally the sun and stars, to probe the atmospheres of Earth and other planets. This presentation will review the diversity of occultation techniques devised over the past 40 years and their many productive uses in Earth and planetary science.